CALIFORNIA ALTERNATIVE FUELS INFRASTRUCTURE PROGRAM EVALUATION 2003

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Executive Summary

Program Overview

The California Alternative Fuels Infrastructure Program provides the foundation needed for the California Energy Commission (Energy Commission) to pursue integrated development of alternative fuel vehicles (AFVs) and their corresponding type of fueling stations. This program allows the Energy Commission to closely monitor non-petroleum fuels and AFV technologies having potential to displace gasoline and diesel usage, and promote statewide infrastructure development through project funding and incentives. As described in the ***California Clean Fuels Market Assessment 2003*** (a separate report available online at the Energy Commission website), the objectives of this program are consistent with, and complementary to, a variety of other state and federal activities that target reduced petroleum dependency in the transportation sector. These include Assembly Bill (AB) 2076 (Shelley, Chapter 936, Statutes of 2000) and Senate Bill (SB) 1170 (Sher, Chapter 912, Statutes 2001).

Under the Budget Act of Fiscal Year 2000-2001, the Energy Commission received $6.0 million to cost share alternative fuel infrastructure projects involving transportation fuels such as natural gas, propane, ethanol, biodiesel and hydrogen. The bulk of the resulting grant awards (about $5.1 million) was allocated towards 41 infrastructure project grants involving natural gas and propane fueling stations. In addition, $300,000 was used to support a hydrogen storage and dispensing project for a fuel cell transit bus application. The remaining funds from the available $6.0 million were spent on a variety of program support and technical assessment efforts.

This report provides a preliminary appraisal of the effectiveness of the Energy Commission's alternative fuel infrastructure program in displacing petroleum fuels and broadening markets for AFV technologies. The ***California Clean Fuels Market Assessment 2003***, presented under separate cover, provides the updated status of alternative fuel markets and AFVs in California, as of mid 2003.

Using a methodology to determine appropriate funding caps as a function of various parameters, the Energy Commission's Transportation Technology Office released three separate solicitations to select the most suitable infrastructure projects for cost share. The primary focus of these solicitations was on the potential to displace petroleum fuels and/or deploy fueling stations that are strategic to California's long-term energy goals. In addition, selection criteria included prospects to support deployment of low-emission vehicles that can lead to significant air quality improvements in California.

Many of the fueling stations supported by the Energy Commission's program only recently became operational, or are still being built. Thus, this evaluation of program effectiveness is preliminary in nature – it can only be based on estimated station throughput and petroleum displacement. Future assessments can use actual

fueling station data to more accurately evaluate petroleum displacement resulting from the Energy Commission's grant funding.

Findings and Recommendations

The Energy Commission's Alternative Fuel Infrastructure Program is a national leader in supporting AFV infrastructure deployment. The program complements and supports other state and federal initiatives involving petroleum displacement, such as those under AB 2076 and SB 1170. It is too soon to derive any concise estimates about the volumes of petroleum fuels that will be displaced at the various compressed natural gas (CNG), liquefied natural gas/liquefied to compressed natural gas (LNG/LCNG) and liquid petroleum gas (LPG or propane) stations that are being supported with grant funding. However, early trends based on input from grant recipients indicate that the CNG, LNG and propane dispensed at these stations will play a very important role in meeting California's petroleum displacement objectives.

Based on information provided by grant recipients, a preliminary near-term outlook was derived for the estimated petroleum displacement at stations funded by the Energy Commission. By June 2004, when all funded stations are expected to be operational, grant recipients collectively estimate that nearly 20 million gasoline gallon equivalents (GGEs) will be dispensed annually at these 19 CNG, 9 LNG/LCNG, and 13 propane stations.

Because these estimates are largely based on anticipated fuel usage, they should be used with caution. Still, the Energy Commission's Alternative Fuel Infrastructure Program will help to displace significant volumes of petroleum fuels, and it is noteworthy that this will occur in sectors where it is most needed. Although 20 million gallons constitute only about 0.09 percent of California's annual gasoline and diesel consumption in the transportation sector, much of this reduced petroleum usage will take place in California's public fleets. This includes 345,000 vehicles in non-state government fleets and approximately 73,000 state fleet on-road vehicles. The state fleet is subject, under SB 1170 to achieve a 10 percent reduction in petroleum usage by January 1, 2005. Over 75 percent of the SB 1170, goals for petroleum displacement can be achieved through dedicated use of CNG and LPG in the state's fleet of about 3,500 bi-fuel vehicles. In order to achieve these goals, the Energy Commission through the Alternative Fuel Infrastructure Program is co-funding new stations where current vehicle fleets and fuel demand exist. These infrastructure expenditures will also play a significant role in meeting the longer-term petroleum displacement goals outlined under AB 2076.

The Energy Commission's funding also plays a positive role in reducing both capital and installation costs at cost-shared stations. Combined with volume-related economies of scale, this can reduce fuel prices to fleets. The greatest effect appears to be reductions in fuel prices at propane stations, due largely to the expansion of propane sales into California's lucrative transportation fuels market. The propane fuel demand from the state's 1,610 bi-fueled pickup trucks can be immediately met

once the stations are up and operational. Historically these bi-fueled vehicles have been driven almost exclusively on gasoline. Propane sales at the 13 new or upgraded automotive stations supported under the Energy Commission's program are expected to translate to very significant price discounts for public fleets using propane vehicles, which can result in annual fuel savings compared to fueling with gasoline. Costs and fuel prices at CNG and LNG/LCNG stations have also been positively impacted by the Energy Commission's grant funding.

The main recommendations of this evaluation are as follows: 1) the Alternative Fuel Infrastructure Program works well under the existing structure, and should be continued; and 2) follow-up assessments should be conducted in approximately 24 months, to quantify actual fuel throughput and petroleum displacement at all supported fueling stations.

Introduction and Background

The California Alternative Fuel Infrastructure Development Program

California's transportation sector is nearly 100 percent dependent on the use of petroleum-based fuels. About 16 billion gallons of gasoline and 5 billion gallons of diesel are consumed in California each year, including fuel dispensed at private fueling stations. The California Energy Commission is the state's primary energy policy and planning agency. For several decades, the Energy Commission has been a national leader in efforts to help diversify transportation fuel markets, including extensive efforts to help deploy and commercialize alternative fuel vehicles (AFVs). An essential element of these efforts has been parallel development of the necessary fueling infrastructures to support AFV use. The State's key mechanism to accomplish this critical mission is the Commission's California Alternative Fuel Infrastructure Program, which is described in a companion report, ***California Clean Fuels Market Assessment 2003*** (available online at http://www.energy.ca.gov/reports). That report includes comprehensive discussions about various types of alternative fuels, the vehicles that use such fuels, and specific infrastructure technologies that are being deployed to dispense them. Details are provided about each fuel's technological maturity and status for achieving sustainable commercialization.

This report, ***California Alternative Fuels Infrastructure Program Assessment***, serves two key purposes. First, it briefly describes the Program's methodology for soliciting, selecting and funding infrastructure projects. Second, it provides a preliminary estimate of how effective the program has been (or will be) in displacing petroleum fuels and broadening markets for AFV technologies. Over the last three years, the Energy Commission has allocated expenditures under the Budget Act of Fiscal Year 2000-2001 to cost share alternative fuel infrastructure projects involving three transportation fuels: natural gas, propane, and hydrogen. The bulk of this funding (about $5.1 million) was allocated towards 41 infrastructure grants involving natural gas and propane fueling stations.[1] These projects are further discussed in Sections 0 and 0, respectively. In addition, $300,000 was used to support a hydrogen storage and dispensing project for a fuel cell transit bus application, as described in Section 0. The remaining funds from the available $6.0 million were spent on a variety of program support and technical assessment efforts.

<u>Program Support and Technical Assessment efforts</u>

- California Clean Fuels Market Assessment, 2001 (P600-01-018)
- California Clean Fuels Market Assessment, 2003 (600-03-015C)
- California Liquified Natural Gas Supply and Demand Report
- California Natural Gas Vehicle Coalition web site support

- Cal-Start Clean Car Maps development

- California Alternative Fuels Infrastructure Program Evaluation 2003 (this report)

Relationship of Alternative Fuels Infrastructure Program to Other Key Efforts

The objectives of the Energy Commission's Alternative Fuels Infrastructure Program are consistent with, and complementary to, a variety of other state and federal activities that target reduced petroleum dependency in the transportation sector. Examples are briefly described below; specific ways in which the infrastructure development program complements these efforts are further described in section titled "Assessment of Program's Preliminary Effectiveness", page 15.

Assembly Bill 2076 (Shelley, Chapter 936, Statutes of 2000) requires, as a significant component, the Energy Commission and the California Air Resources Board to develop and submit a plan to the Legislature to reduce petroleum dependence in California. Use of alternative fuels in the transportation sector is part of that plan, which was recently completed.

Senate Bill 1170 (Sher, Chapter 912, Statutes 2001) requires the Energy Commission, CARB and the Department of General Services to examine strategies to reduce petroleum consumption in the state fleet by no less than 10 percent on or before January 1, 2005. A resulting report to the Legislature found that exclusively using alternative fuels (CNG or propane) in the state's fleet of 3,572 bi-fuel vehicles would achieve nearly 75 percent of the targeted reductions in petroleum use.[2] The report noted that achieving this goal would require major expansion of the existing fueling infrastructure available to state fleets using bi-fuel vehicles.

The Driving Green Task Force is a collaboration of 25 state agencies (led by the State and Consumer Services Agency) that is addressing many of the topics and barriers under SB 1170. This task force may serve as a policy and planning mechanism to implement many of the SB 1170 report recommendations, including those involving alternative fuels.

The Joint Agency Climate Team (JACT) is a group of more than 15 state agencies chaired by CARB, which develops policy and program initiatives to reduce greenhouse gas emissions. Greater use of alternative fuels is among the approaches under consideration for achieving such reductions.

The federal Energy Policy Act of 1992 (EPAct) was passed by Congress to reduce America's dependence on imported petroleum. It requires certain fleets (including state and local government fleets) to acquire vehicles capable of operating on non-petroleum fuels.

Assessment Scope, Methodology, Source of Inputs and Limitations

A key objective of this assessment was to obtain a realistic estimate on the volume of alternative fuel that will be dispensed at each funded fueling station over its first

three years of operation. Converting the sum of these alternative fuel "throughput" volumes to their energy equivalents can yield ballpark estimates of how much gasoline and diesel fuel will be "displaced" (i.e., their consumption will be avoided) in California's transportation sector. Thus, to the extent that such information exists, this report attempts to accurately estimate fuel displacement that can be attributed to the Energy Commission's funding. In the case of projects that lacked key information at the time of this assessment, best efforts were made to obtain other quantitative and qualitative metrics for determining project effectiveness.

The Energy Commission's individual grant managers served as the initial and primary liaisons with grant recipients. Feedback was sought from organizations that will utilize the supported station (usually public agencies), and/or private fuel providers in partnership with those agencies. Inputs that were requested of each grantee included the following:

- Fuel and station type
- Total project cost and amount of Energy Commission funding
- Station owner / operator's estimated completion date
- Station owner / operator's estimated fuel throughput over next three years
- Qualitative and/or quantitative estimates about the value of the funding towards AFV deployment

While much of the requested information was provided by grantees, in some cases key information and data were not available. As of mid 2003, some of the stations were still in the planning or construction phases, and had not yet started dispensing fuel. To fully pursue a primary metric regarding effectiveness of the Energy Commission's program – the estimated "Dollars Spent / Btu[3] of petroleum displaced" – efforts were made to follow-up with each program grantee. The data in this report reflect a combination of the raw input provided by program grantees, and estimates and interpretations that were necessary to expand, clarify or refine that input.

The following caveats and limitations are noted for this assessment:

- Most data involve future estimates about volumes of fuel to be dispensed at the supported stations by mid 2004. The extent to which these estimates are based on real-world fuel-dispensing experience (e.g., from data at similar stations) is largely unknown.
- For all information that was received, reasonable attempts were made to corroborate the input, and clarify or expand where important. However, rigorous verification of the information provided was beyond the scope of this study.
- Not all grantees responded with detailed information about their infrastructure projects. Many of the inputs for this assessment ultimately had to be pieced together through estimations and interpolations made by authors of this report.

In assessing the preliminary effectiveness of the Energy Commission's Alternative Fuels Infrastructure Program, it is also important to keep a proper perspective on the magnitude of the task at hand. The California transportation sector consumes 21

billion gallons of gasoline and diesel fuel per year (combined). Program achievements in terms of petroleum displaced will be very modest in these early years of AFV deployment. The Energy Commission's program and other similar efforts have provided just a fraction of the funding needed to compete and achieve sustainable AFV commercialization. Very large new investments in AFV fueling stations will be needed to effect major expansions in AFV commercialization (see final report entitled ***Reducing California's Petroleum Dependence***, August 2003, online at http://www.energy.ca.gov/reports/2003-08-14_600-03-005.PDF).

Program Goals, Structure and Expenditures by Fuel Type

Program Goals and Structure

The goal of the Energy Commission's Alternative Fuel Infrastructure Program is to provide cost-share assistance for AFV fueling facility projects in California. A specific objective is to help public fleets expand their use of alternative fuels by helping offset capital equipment and installation costs at strategically located stations that can offer alternative fuels at competitive prices. In addition, funded projects are intended to provide applicants and other program participants with experience and knowledge of alternative fuel storage and dispensing systems. Program participants include state and local government agencies, automobile manufacturers, alternative fuel suppliers, storage and equipment component manufacturers, and AFV end users.

Grant funding applicants must be either public agencies or private entities that partner or assist public agencies that will own, operate, or be a primary user of the AFV fueling facility. Public agencies include cities, counties, special districts, universities, colleges, federal and state agencies.

Under this program, the Energy Commission uses a systematic process to establish the types of AFV infrastructure projects to fund, and the magnitude of eligible grant funding. As previously described, the biennial ***California Clean Fuels Market Assessment*** helps establish the most recent "landscape" for AFV technologies and their corresponding infrastructure in California. This assessment, which was initially done in 2001 and then again in 2003, highlights the infrastructure-development needs for fuels and technologies with good potential to displace petroleum use in California's transportation sector.

Guided by the findings and recommendations of the first ***Clean Fuels Market Assessment***, the Energy Commission prepared and released three separate competitive solicitations for infrastructure projects, beginning in early 2001. To establish funding caps as a function of total project costs, potential projects were grouped into three categories: Small (total cost from $66,667 to $249,999), Medium ($250,000 to $833,332), or Large ($833,333 and up). These categories and funding ranges were selected to help provide equity across all sizes and types of infrastructure projects. "Three-tiered" funding formulas were applied to determine the maximum award from the Energy Commission, as shown in Table 1.

Table 1.
Summary of Funding Formulas for New Projects (Three-Tiered Approach)

Project Size by Total Cost	Minimum Total Project Cost	Maximum % of Total Project Cost for Funding Award	Maximum Award from CEC
Small	$66,667	X 75%	= $50,000
Medium	$250,000	X 50%	= $125,000
Large	$833,333	X 30%	= $250,000

To further optimize use of the available grant funding, the Energy Commission structured each of the three solicitations to target specific types of alternative fuel station projects. The first and second solicitations sought projects proposing to establish new fueling facilities, with a maximum funding allocation of $250,000. The third and final solicitation sought to provide up to $100,000 to cost share new fueling stations, while also allowing up to $30,000 to upgrade or expand existing alternative fuel stations.

The three AFV infrastructure solicitations released by the Energy Commission were carefully structured to fit within California's "big-picture" energy goals. The focus of these solicitations was on potential to displace petroleum fuels, but selection criteria also included prospects to support new alternative fuel fleets, or meet other strategic infrastructure needs. This system allows projects involving small and medium fueling stations to receive grant funding, even though they cannot compete with the largest and highest-throughput stations on the basis of petroleum-displacement potential. As a collective approach, this system has the best potential to result in a sustainable network of AFV fueling stations across California.

Overview of 2000-2001 Program Expenditures

As Table 2 shows, about $5.1 million of the available $6 million was expended to support 41 individual projects involving natural gas and propane fueling stations. Specifically, in response to the three solicitations noted above, grants were provided to cost share 19 CNG stations, 9 LNG stations (some of which included the "LCNG" feature[4]), and 13 propane stations. These awards were made to public agencies or private companies working in partnership with such agencies. The total cost of building or upgrading all 41 fueling stations was estimated to be $29 million; the Energy Commission's total grant funding of $5.1 million constituted 17.5 percent. The remainder of the $6 million was allocated to miscellaneous infrastructure-related projects, assessments and support activities, including $300,00 for a hydrogen infrastructure project described in Section 0 of this report.

Table 2.
Total Expenditures for Natural Gas and Propane Fueling Infrastructure

Station Type by Fuel	No. of Fueling Stations	Total Station Costs	Energy Commission Contribution	% of Commission Contribution
CNG	19	$13,582,184	$ 2,599,927	19.1%
LNG/LCNG	9	$14,218,932	$ 2,091,000	14.7%
Propane (LPG)	13	$ 1,197,877	$ 373,063	31.1%
	41	**$28,998,993**	**$ 5,063,990**	**17.5%**

Table 3 details the funding allocations for specific stations under the first, second, and final infrastructure solicitations. It includes reference to the types of light-, medium-, or heavy- duty vehicles that each station is expected to primarily serve (e.g., taxicabs, transit buses, refuse haulers and transfer trucks, street sweepers).

Table 3.
Energy Commission Funding Allocations by Solicitation

Table 3. Energy Commission Funding Allocations by Solicitation

Infrastructure Project / Fueling Station	Total Project Cost	Energy Commission Allocation	Type of Alternative Fuel Station	Primary Type(s) of Vehicle(s) to be Fueled at Station
City of Burbank	$791,842	$125,000	CNG	Mixed of LDVs and MDVs
City of Fremont	$510,299	$144,000	CNG	Street Sweepers, LDVs, MDVs
City of Los Angeles	$2,000,000	$250,000	L/CNG*	Mix of HDVs, MDVs, LDVs
Omnitrans Montclair	$1,700,000	$250,000	L/CNG*	Transit Buses
Omnitrans San Bernardino	$2,500,000	$250,000	L/CNG*	Transit Buses
San Jose International Airport	$1,282,333	$250,000	CNG	Buses, Taxicabs, LDVs, Other
SCAQMD Headquarters, Diamond Bar	$677,975	$169,500	CNG	Mix of LDVs and MDVs
Socal Gas Company	$550,000	$125,000	CNG	Mix of LDVs and MDVs
Taormina Industries	$803,862	$241,000	L/CNG*	Waste Hauling / Transfer Trucks
University of California, Santa Cruz	$282,500	$125,000	CNG	Street Sweepers, Trucks, Vans
Yolo County Transit District	$1,065,968	$100,000	CNG	Transit Buses
Totals for First Solicitation	**$12,164,779**	**$2,029,500**		
City of Los Angeles	$3,646,300	$250,000	L/CNG*	Mix of HDvs, MDVs, LDVs
City of Fresno, Fresno Area Express	$1,500,000	$250,000	CNG	Transit and Paratransit Buses
City of Industry Disposal Company	$856,638	$196,427	CNG	Waste Hauling / Transfer Trucks
City of Commerce	$1,000,000	$250,000	L/CNG*	Buses, Mix of LDVs and MDVs
Downs Commercial Fueling (Temecula Facility)	$870,000	$250,000	L/CNG*	Mix of HDvs, MDVs, LDVs
County Sanitation Districts of LA County	$995,070	$250,000	L/CNG*	Waste Hauling / Transfer Trucks
Delta Liquid Energy / Caltrans / San Luis Obispo APCD	$920,000	$250,000	LPG (10 Stations)	State Fleet Bi-Fuel Pickups
City of Colton**	$1,700,000	$250,000	CNG	School Buses, City Yard MDVs
Southwest Transportation Agency	$851,196	$150,000	CNG	School Buses
City of Placentia	$750,000	$225,000	CNG	City Yard LDVs, MDVs
Totals for Second Solicitation	**$13,089,204**	**$2,321,427**		
Calexico Unified School District	$558,210	$100,000	CNG	School Buses
City of Visalia	$850,418	$100,000	CNG	Mix of Buses, LDVs, MDVs
Pinnacle CNG / Yolo Solano APCD / DGS OFA	$98,000	$30,000	CNG	Mixed Fleet of LDVs, MDVs
Pinnacle CNG / San Jose USD	$90,000	$30,000	CNG	School Buses
City of Lancaster / Power Systems Associates	$350,000	$100,000	L/CNG*	Mix of HDVs, MDVs, LDVs
Riverside Transit Agency	$187,434	$30,000	CNG	Transit Buses
San Luis Butane	$63,754	$30,000	LPG (2 Stations)	Mix of LDVs and MDVs
San Luis Butane	$214,123	$93,063	LPG	Mix of LDVs and MDVs
Santa Cruz Metropolitan Transit District	$384,371	$100,000	CNG	Transit Buses
City of Anaheim / Yellow Cab Company	$595,000	$100,000	CNG	Taxicabs, MDVs
Totals for Final Solicitation	**$3,391,310**	**$713,063**		
Grand Total of Energy Commission Funding Under Budget Act of Fiscal Year 2000-2001				**$5,063,990**

*For simplicity, all 9 LNG stations are designated as L/CNG, although some may not initially be built with the capability to dispense CNG

**the City of Colton grant was canceled after announcement of the award

Additional details are provided below about these selected alternative fuel infrastructure projects, by station type and other characteristics. Estimates of their potential to individually and collectively displace petroleum fuel usage are provided in the section titled: “Assessment of Program’s Preliminary Effectiveness” on page 15.

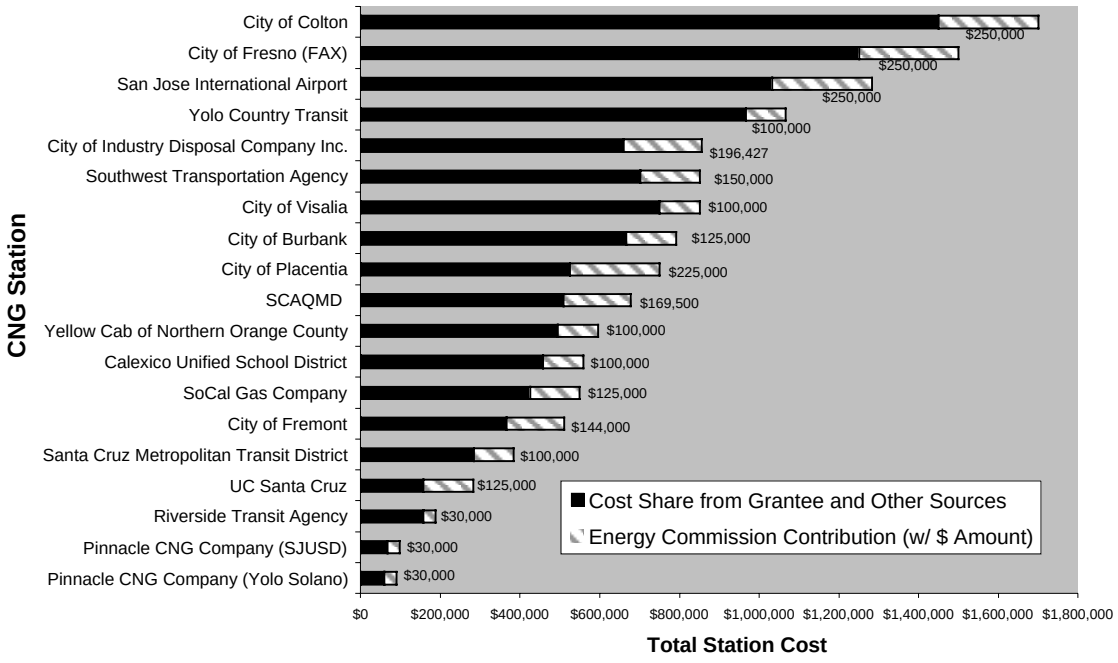
Support Rationale and Funding Amounts for Natural Gas Fueling Stations

Natural gas continues to be the leading alternative fuel in California, in terms of commercially available low-emission vehicles and numbers of stations deployed specifically to dispense motor vehicle fuel. Much progress has been made over the last five years to expand California’s natural gas fueling infrastructure. According to a recent estimate from the California Natural Gas Vehicle Partnership, more than $31 million of public funds have been invested to build 109 natural gas stations since 1998.[5] The Energy Commission’s alternative fuel infrastructure program has been a cornerstone of these statewide efforts. As can be tallied from Table 2 above, $4.69 million from the 2000-2001 program budget has been allocated to cost share 28 new

CNG, LNG and LCNG stations, for a total cost of about $28 million. In line with the recommendations of the ***California Clean Fuels Market Assessment*** (2001 version), these allocations were focused on stations that serve (or will serve) vehicle types and applications that can best displace petroleum fuels and, to the extent feasible, also provide emissions reductions in the mobile source sector.[6] This includes the following combinations of fuels and vehicle types:

- CNG – transit buses, school buses, light- and medium-duty fleet vehicles for cities and municipalities, light-duty taxi fleets, and medium-duty delivery vans
- LNG – refuse haulers, return-to-base Class 8 delivery trucks, and transit buses
- LCNG – light- and medium-duty vehicles that are affiliated with or nearby to heavy-duty fleets using LNG

Figure 1 shows a breakdown of the CNG stations that the Energy Commission supported,[7] with the total cost shown as well as the Energy Commission's cost share. On average, the Energy Commission funded 22 percent of the total cost for these CNG stations.



NOTE: the grant for the City of Colton's station has subsequently been cancelled
Source: California Energy Commission, data provided to TIAX, March 2003

Figure 1. Total Cost and Energy Commission Funding for CNG Stations

Figure 2 shows a breakdown of the LNG and LCNG stations that the Energy Commission supported, with total costs and the Energy Commission's cost share. On average, the Energy Commission funded 15 percent of the total cost for these stations.

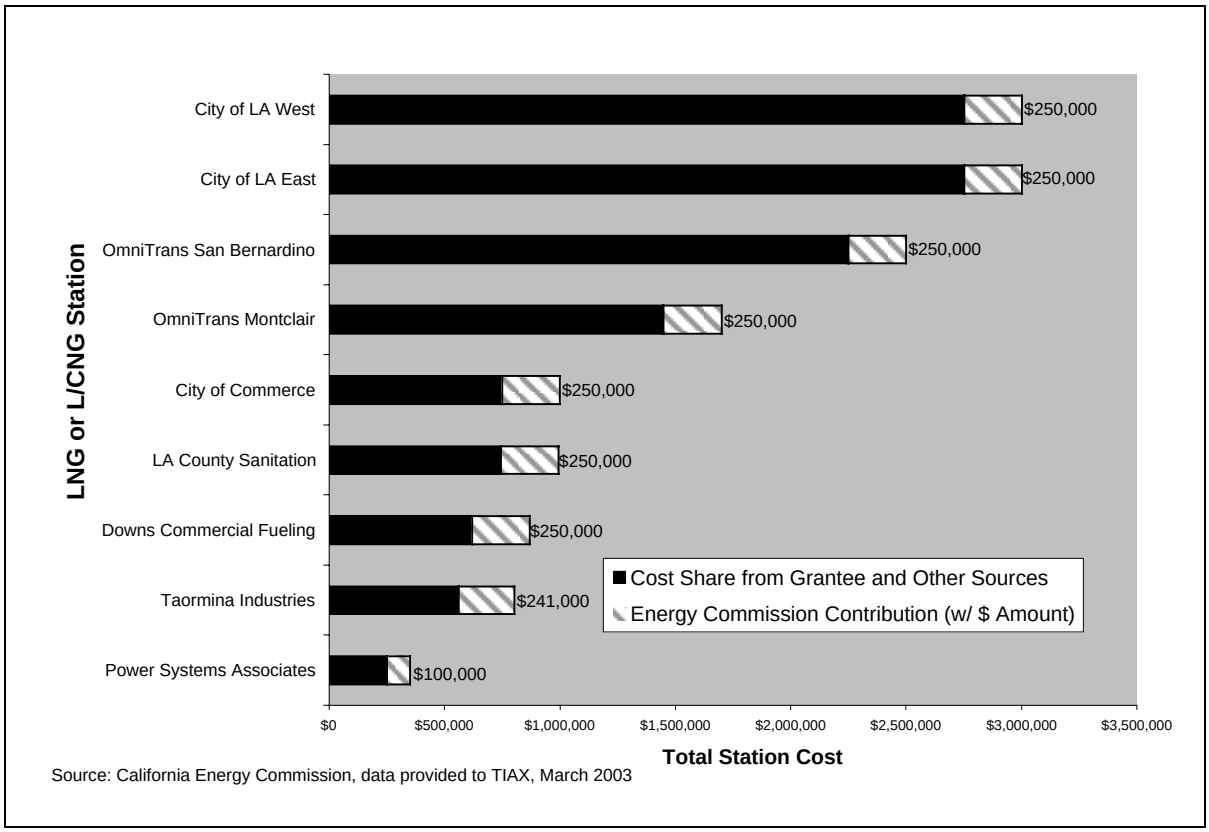


Figure 2. Total Cost and Energy Commission Funding for LNG and LCNG Stations

Assessments of the potential for these various natural gas stations to displace petroleum fuels are provided in the section titled: "Assessment of Program's Preliminary Effectiveness" on page 15, along with other metrics for determining the effectiveness of the Energy Commission's alternative fuels infrastructure development program.

Funding for Propane Fueling Infrastructure and Rationale for Support

Propane vehicles have potential to significantly displace petroleum fuels in California, and in some cases provide air quality benefits (see ***California Clean Fuels Market Assessment 2003***). The Energy Commission's allocation of $373,063 to fund 13 propane stations has significantly moved California towards realizing that potential. These allocations were focused on stations that will serve Caltrans and other California agencies in refueling the state's large fleet (approximately 1,610) of bi-fuel pickup trucks. Historically, these vehicles have been driven exclusively on gasoline, but Caltrans and other state agencies have recently made new policy commitments to fuel bi-fuel vehicles with propane, as often as possible. A key factor in this decision was the availability of grant funding from the

Energy Commission to cost share new and expanded propane stations at strategic locations throughout California.

These particular grants for 13 propane stations took on even greater importance with the passage of Senate Bill 1170 in 2002. SB 1170 required the Energy Commission, the California Air Resources Board and the Department of General Services to make recommendations how to achieve a minimum 10 percent reduction in the state fleet's petroleum use by January 2005. In a March 2003 report to the Legislature, the three agencies jointly concluded that the single most significant short-term strategy to reduce petroleum usage in the state fleet of nearly 73,000 vehicles would be to regularly operate its bi-fuel vehicles on propane instead of gasoline. This measure alone can meet up to 44 percent of the state fleet's minimum goal for petroleum reduction by January 1, 2005. With all 13 new or upgraded propane stations expected to come on line by late 2003 or early 2004, the Energy Commission's program has addressed a very significant barrier towards achieving SB 1170's challenging requirements.

The total cost of the 13 propane stations supported under the infrastructure development program was approximately $1.2 million. The Energy Commission's funding of $373,073 constituted a 31 percent cost share on average. Assessments of the potential for these various propane stations to displace petroleum fuels are provided in the section titled: "Assessment of Program's Preliminary Effectiveness" on page 15.

Funding for Hydrogen Fueling Infrastructure and Rationale for Support

Many experts believe that over the next few decades, the internal combustion engine will gradually be replaced with direct-hydrogen fuel cell technology as the primary power unit of California's transportation sector. However, achieving widespread use of hydrogen in the transportation sector will require vehicle, fuel-production and infrastructure investments of very large proportions. Activities under the California Fuel Cell Partnership, which includes the Energy Commission, are addressing some of these issues. The Partnership has announced plans to begin demonstrating up to 60 fuel cell vehicles in 2003, and some vehicles have already been delivered. Beyond demonstrations, among the first vehicles that will be commercially deployed are transit buses powered by fuel cells (similar to those that are already carrying passengers in public demonstration programs in several North American cities). In addition, CARB's recent modification to the ZEV regulation appears to provide new impetus for automakers to commercialize light-duty fuel cell vehicles over the longer term (10 years and beyond).

As of mid 2003, there are only a few facilities in California specifically designed to dispense hydrogen as a motor vehicle fuel, on strictly a demonstration scale. Gradually, the number of funding programs for developing hydrogen infrastructure is continuing to grow in California, with the Energy Commission taking a leadership role in conjunction with the California Fuel Cell Partnership. For example, using $300,000 of the $6 million allocated under the Budget Act of Fiscal Year 2000-2001, the Energy Commission awarded a 2002 grant to the Santa Clara Valley Transit Authority to cost share design and construction of a hydrogen fueling facility at the VTA's Cerone Bus Division.[8] Other hydrogen infrastructure projects recently

supported by the Energy Commission are described in ***California Clean Fuels Market Assessment 2003***.

These efforts by the Energy Commission to support hydrogen infrastructure currently involve demonstration-scale activities where relatively small volumes of hydrogen will be used over the next decade. As such, the metrics of success involve advancing fuel cell and hydrogen technology, lowering costs, and educating end users about hydrogen as a transportation fuel. It is premature to assess the longer-term potential for hydrogen stations funded by the Energy Commission to displace significant volumes of petroleum fuels. This may be the subject of program assessments in the future, however.

Assessment of Program's Preliminary Effectiveness

Importance and Challenges of Accurately Estimating Station Throughput

In evaluating the potential of a given alternative fuel station to displace petroleum fuels, the "throughput" (volume of fuel that will be dispensed over time) is perhaps the most important and challenging metric to estimate. Throughput at each alternative fuel station is (or will be) essentially a function of 1) the types and numbers of AFVs fueled, 2) how frequently they fuel, and 3) the volume of fuel dispensed during each fueling event. Typically, the highest-throughput stations are those that regularly serve large numbers of heavy-duty vehicles, which store the most fuel and have the highest per-vehicle fuel consumption rates. Currently, for alternative fuels this description most consistently fits stations that serve major refuse hauler and transit bus operations, where throughput can be as high as 300,000 gasoline gallon equivalents (GGE) per month. However, stations that serve at least one "anchor fleet" of high-mileage medium- or light-duty vehicles (e.g., taxicabs and shuttle vans) can also have relatively high throughput. These stations that involve regular and predictable fueling demand in the form of anchor fleets are easier to accurately estimate fuel throughput.

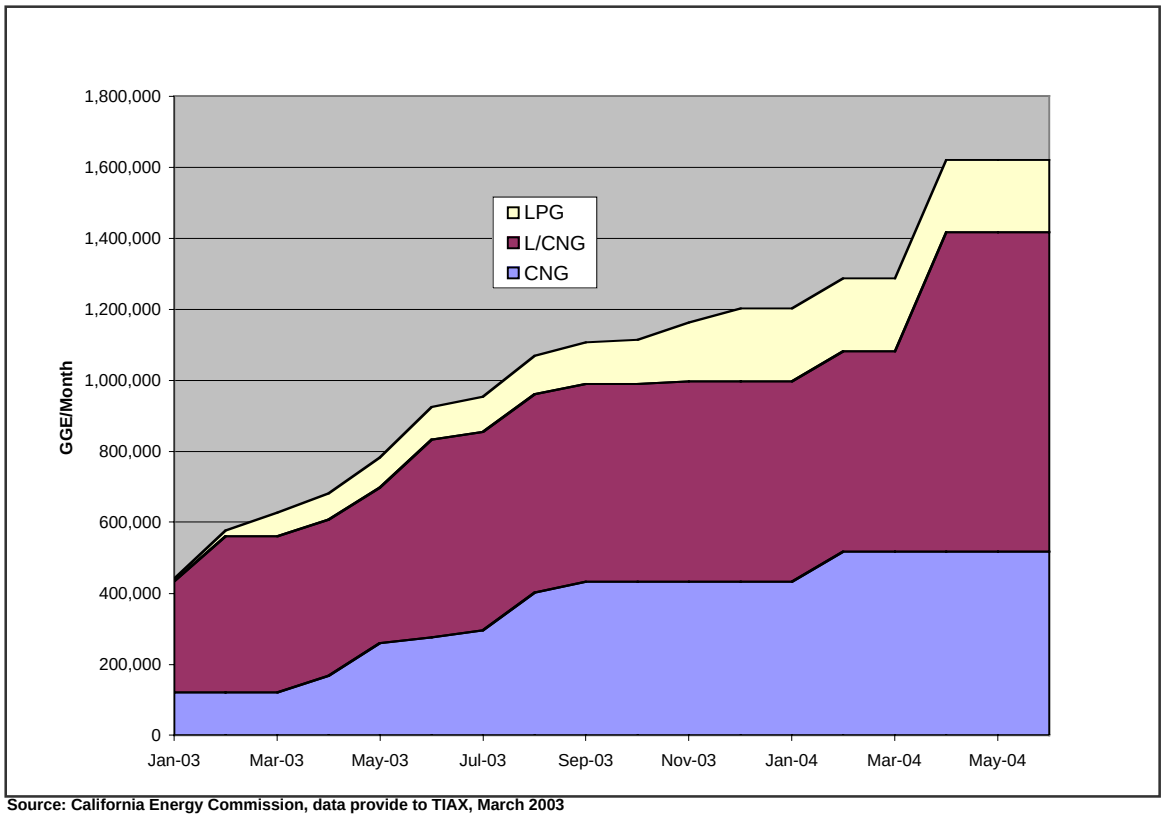
The Energy Commission's alternative fuel infrastructure program recognizes that high-throughput stations with anchor fleets are the cornerstones of early AFV deployment. However, the program also supports the longer-term need to deploy stations offering fuel to the general motoring public with the full amenities of modern gasoline stations. These public-access stations tend to host intermittent fueling events without use by an anchor fleet; as such, they are harder to estimate for fuel throughput. Thus, it must be noted that their value towards meeting longer-term objectives of the Energy Commission's overall mission may not be completely assessed on the basis of near-term displacement of petroleum fuels.

Many of the fueling stations supported under the Energy Commission's funding only recently became operational, or are still being built. Therefore, this evaluation of program effectiveness is preliminary in nature – it can only be based on estimated station throughput and petroleum displacement. As a first step, grant recipients were asked to estimate fuel throughput over the first three years that their stations will be operational, based on existing, committed and potential vehicles. Both volume and energy-content estimates were submitted, using a variety of different units of measure. For example, most of the estimates for throughput at CNG stations were expressed in "therms" of energy or "gasoline gallons equivalent" (GGE), while liquefied alternative fuels (LNG and LPG) were usually expressed in gallons ($gallons_{LNG}$, $gallons_{LPG}$, or GGE). In preparing this report, all units were converted to a common energy "currency." For volumetric measures of energy content, GGE is used as the currency because it has become the standard when discussing alternative transportation fuels.[9] One "therm" of energy is equal to 100,000 Btu, or

about 0.82 GGE using California reformulated gasoline as the baseline. When discussing price-related quantities involving energy content, this report uses one million Btu (abbreviated MMBtu). One MMBtu (10 therms) is equal to about 8.2 GGEs.

Estimated Throughput Over Time by Fuel Type and Individual Stations

Starting with information provided by grant recipients, and making adjustments based on engineering judgment where necessary, a preliminary near-term outlook was derived for the estimated petroleum displacement at stations funded by the Energy Commission. Figure 3 breaks out the cumulative estimated fuel throughput that will occur at the three major types of stations (CNG, LNG/LCNG, and LPG) over a period of about 18 months. By June 2004, when all 41 stations are expected to be operational,[10] grant recipients collectively estimate that 1.62 million GGE/month (19.44 GGE/year) will be dispensed at these three types of stations.



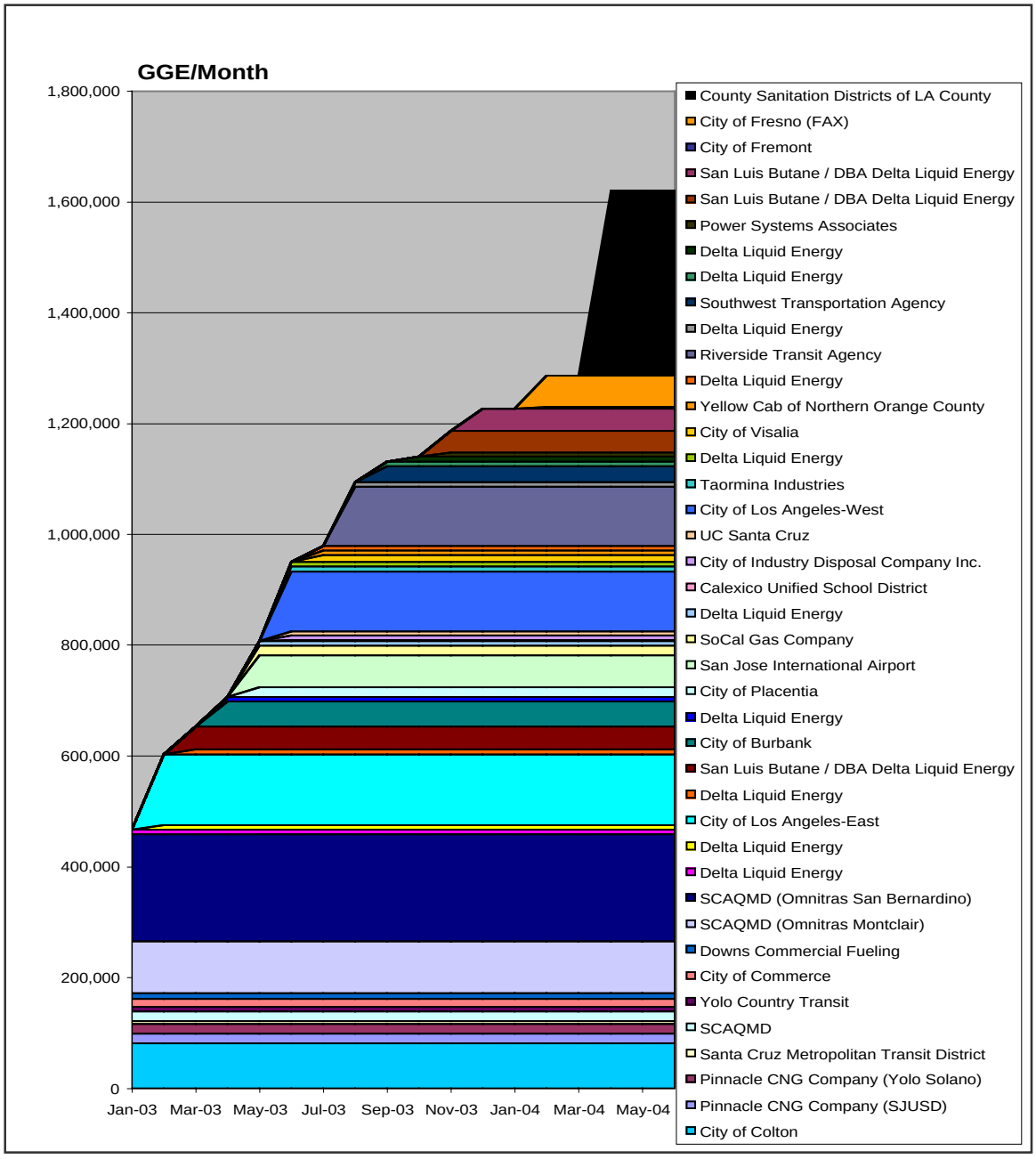
Source: California Energy Commission, data provide to TIAX, March 2003

Figure 3. Cumulative Estimated Throughput per Month by Fuel Type

This figure also shows that the LNG/LCNG stations (nine in total) are predicted to dispense the largest volumes (in GGEs) of alternative fuel by June 2004, followed by the CNG stations and then LPG stations (19 and 13 in total, respectively). Even with fewer stations, the LNG/LCNG stations are estimated to dispense 55 percent of the 1.62 million GGEs of monthly throughput by June 2004. According to estimates from grant recipients, the average throughput at these LNG/LCNG stations will be

99,790 GGE per month – almost four times the average of the CNG stations (27,259 GGE) and more than six times the average of the LPG stations (15,705 GGE) over the same time period. The trends in these estimates are not unexpected – unlike CNG and LPG stations, today's LNG stations (with or without the LCNG feature) are *inherently linked* to high-fuel-use applications involving heavy-duty vehicles, such as the LCNG station awarded to the Los Angeles County Sanitation Districts to fuel refuse haulers. By contrast, some of the 19 funded CNG stations will fuel relatively small fleets of school buses or light-duty vehicles. The 13 propane stations are likely to fuel bi-fuel LDVs and MDVs almost exclusively.

Figure 4 provides a more detailed breakout of the cumulative estimated fuel throughput, as a function of each funded station coming on line from January 2003 to June 2004.



Source: California Energy Commission data provided to Tiax, March 2003

Figure 4. Cumulative Estimated Throughput for Individual Stations

These data indicate that potentially, significant volumes of petroleum fuel will be displaced by mid 2004 at the 41 alternative fuel stations awarded under the Energy Commission's three solicitations. Although 1.62 million GGEs per month constitute only about 0.09 percent of the gasoline and diesel consumed by California's transportation sector, much of the reduced petroleum usage will accrue in California's public fleets (federal, State, city, county, and special districts). This includes the state fleet of approximately 73,000 on-road vehicles, which is targeted under SB 1170 for a 10 percent or greater reduction in petroleum usage *by January 1, 2005*. Nearly 75 percent of the SB 1170 goals for petroleum displacement can be

achieved through dedicated use of CNG and LPG in the state's fleet of bi-fuel vehicles – occurrences that would not be feasible without the new stations being built under the Energy Commission's program. Over the longer term, these infrastructure expenditures will play a significant role in meeting the petroleum displacement objectives outlined in AB 2076.

It is important to realize, however, that estimates for petroleum fuel displacement by these 41 natural gas and propane stations are based on preliminary information provided by grant recipients. Caveats include the following:

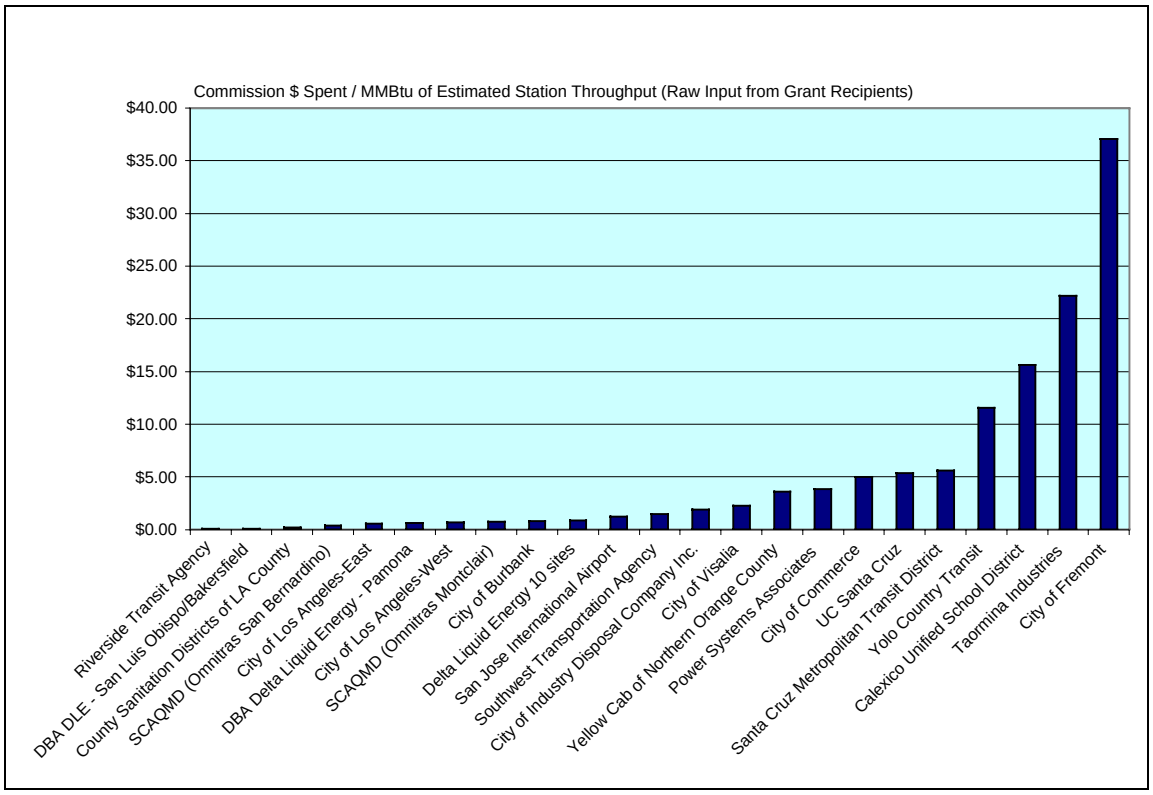
- In certain cases, insufficient data existed for the grant recipients to make accurate throughput estimates. In other cases, grant recipients may have misinterpreted survey questions and submitted incomplete information.
- Much of the original input required follow-up discussions with grant recipients to better understand assumptions in their estimates. Such discussions did not always yield further useful information. In some cases, it was necessary to use engineering judgment to adjust or interpolate data inputs.
- Assumptions for station growth (e.g., increased numbers of AFVs through fleet replacement or expansion) are mostly unknown. A financially viable station can double in capacity, providing a beneficial growth increment. Several of the funded stations include allowances for expansion, such as room for additional fuel storage tanks, but few details could be obtained about potential station improvements. Accurate depictions of station capacities and throughput in the future would require detailed growth rates for user fleets and the individual stations that will serve them.

In sum, actual throughput at any given station – and the corresponding volume of petroleum fuels displaced – is likely to vary significantly from these estimates, even for the relatively near-term time frame of June 2004.

Energy Commission Funding per Estimated Petroleum Displacement Potential

Individual Stations Funded

An objective of this assessment was to translate estimated throughput numbers at the funded stations into a measure of effectiveness for the Energy Commission's program. The desired metric is "dollars spent per fuel displaced." The numerator is simply the amount of funding provided by the Energy Commission for each project. To derive the denominator, each station's throughput (as estimated by the grant recipient) was converted from GGE to MMBtu.[11] The results are depicted in Figure 5, which provides the Energy Commission's "cost" (dollars spent) per MMBtu of fuel throughput based on the original, somewhat raw inputs from grant recipients.



Source: California Energy Commission data provided to Tiax, March 2003

Figure 5. Commission $ Spent per Estimated Station Throughput (Raw Input)

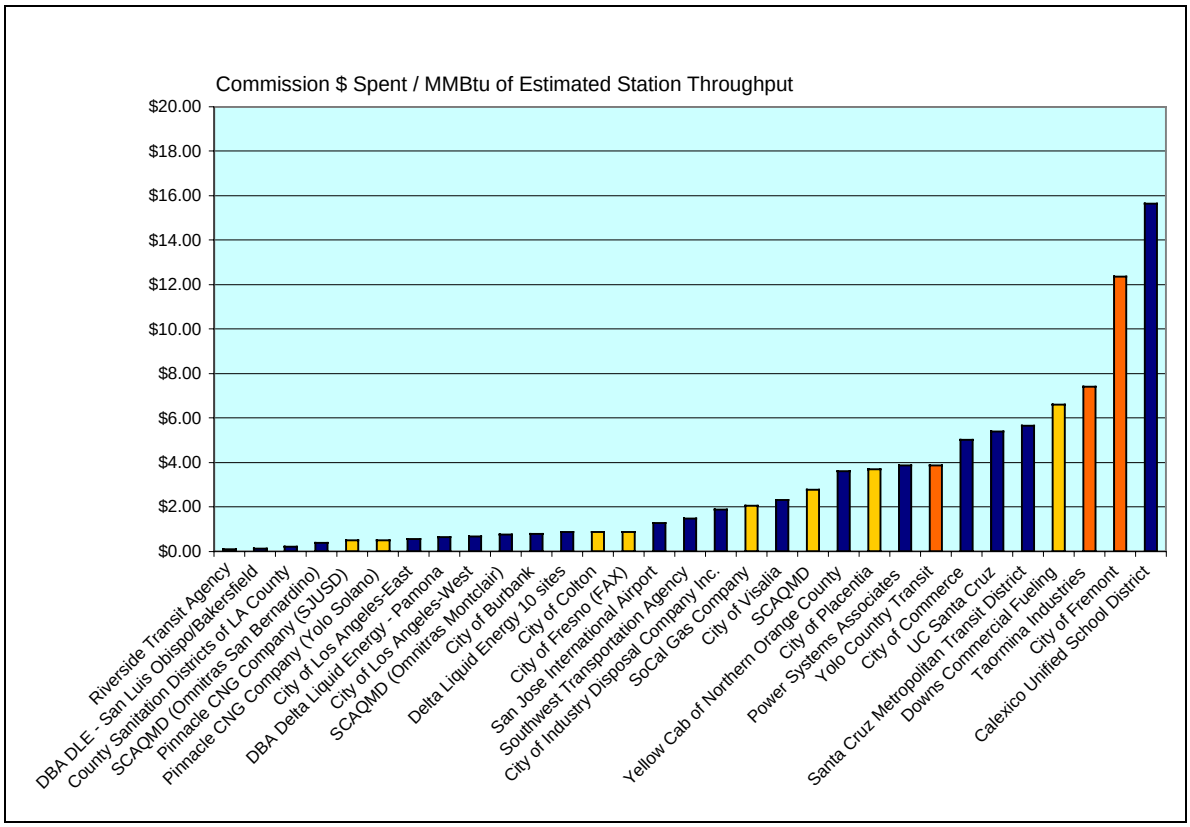
The data depicted in Figure 5 present an incomplete picture that can be misleading. First, as already noted, some of the raw input received from grant recipients was lacking detail or appeared erroneous. Second, quantifying the specific contributions made by the Energy Commission's funding can be complex. For example, some infrastructure grants involved entirely new fueling stations, while others involved expansions or upgrades to existing stations. In such cases it can be especially challenging to accurately estimate how the Energy Commission's grant dollars will translate to incremental station throughput and the corresponding petroleum displacement.

Secondary research was conducted to better understand the nature of the funded stations and more accurately estimate throughput potential. Even with enhanced information, some stations appeared to have unusually high costs per estimated petroleum displacement. Little correlation was found between the amount of the Energy Commission's grant award for a given station and its estimated petroleum displacement contribution. In part, this can be attributed to the fact that grant awards are capped by project size and type, e.g., a CNG station with a total cost of $833,000 would be eligible for the same $250,000 award as a $2.5 million CNG station. The total cost of each project was evaluated to get a more complete picture of how the Energy Commission's funding contribution will help to effect petroleum displacement. To the extent feasible within this report's scope and funding, further

checking was conducted to better understand reasons for anomalies in the data, and adjustments were made that could be supported by engineering judgment.

With these types of adjustments, individual fueling stations funded under the Energy Commission's 2000-2001 program can be compared and informally ranked in terms of the desired metric: Energy Commission dollars spent per estimated MMBtu displaced.

Figure 6 shows the results for all funded stations. Lightly shaded bars designate stations for which no throughput estimates were provided by grant recipients; instead, throughput estimates had to be derived using the best available information and engineering judgment. Medium-shaded bars designate stations for which throughput data were provided but adjustments were deemed necessary based on engineering judgment.



Source: California Energy Commission data provided to Tiax, March 2003

Figure 6. Commission $ Spent per Estimated Station Throughput (Corrected)

Some trends seen in Figure 6 are consistent with expectations, while others are not. Further insight can be gained by looking at station cost and displacement trends as a function of the type of fueling station funded.

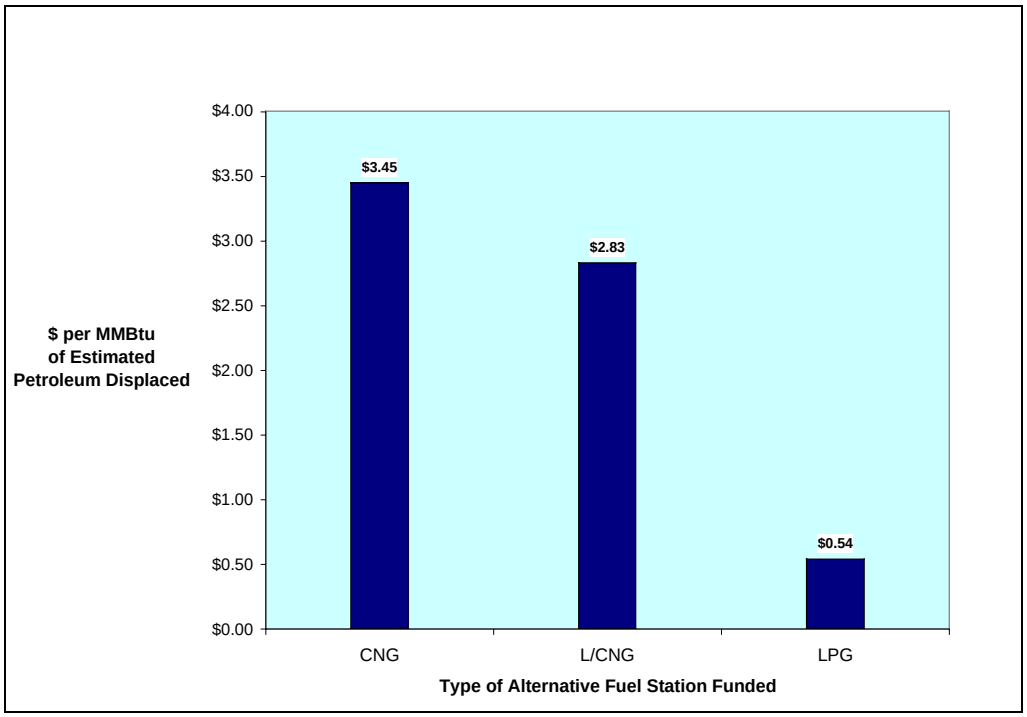
Funding per Estimated Station Throughput, by Fuel Type

Figure 7 compares the average number of Energy Commission dollars spent for the three station types (CNG, LNG/LCNG, or propane) per MMBtu of estimated fuel throughput. At face value, these data indicate that supporting propane stations to facilitate petroleum displacement is roughly five to six times more cost effective than supporting CNG or LNG/LCNG stations. While the general trends are not unexpected, considerable care must be used when interpreting the numbers shown in Figure 7. As previously noted, estimates for station petroleum displacement are based on future throughput values entailing numerous uncertainties. In addition, accurately assessing the specific contribution of the Energy Commission's funding may not be possible without extensive additional analysis and investigation. Still, the following observations can be made towards better understanding the trends shown:

- Propane stations are inherently less expensive to build than natural gas stations (either CNG or LNG/LCNG). In addition, some of the funded propane sites were upgrades and expansions of existing propane fueling sites rather than new construction efforts. These are reflected in the relatively low average funding that the Energy Commission provided per propane station ($44,354), compared to the average amount given to CNG and LNG/LCNG stations ($136,838 and $232,333, respectively). It is primarily the low average funding per station that makes the propane station the most cost-effective of the three station types.

- In addition, the estimated throughput of these propane stations may be more speculative than estimates for the CNG and LNG/LCNG stations. Increasingly, natural gas stations are being built by experienced fuel providers that use business models based on proven profiles for fuel demand. By contrast, to date there are very few propane stations in California that have specifically been designed to refuel motor vehicles. Compared to NGVs, there is greater uncertainty regarding the numbers and types of propane-fueled vehicles on the road in California. The main users for the 13 propane stations are expected to be the state's fleet of about 1,610 bi-fuel vehicles. If those vehicles are operated 100 percent on propane (as targeted by the state under SB 1170), about 2.0 million gallons of gasoline will be displaced each year. Grant recipients for the 13 propane stations estimated that a total of about 2.5 million GGEs will be dispensed per year. This suggests that the estimated throughput total for all 13 propane stations is optimistic.

- The higher estimated throughput at LNG/LCNG stations is the major reason that these types of stations are predicted to displace petroleum fuel more cost effectively than CNG stations. While it's true that the Energy Commission provided nearly 70 percent more funding per station to support LNG/LCNG infrastructure compared to CNG, the average throughput at the LNG/LCNG stations is estimated to be about 3.4 times higher. This is because the nine funded LNG/LCNG stations are of similar size and purpose – they will primarily serve medium to large fleets of HDVs. By contrast, the 19 CNG stations vary more in size and purpose. Many are likely to mostly serve smaller numbers of LDVs and MDVs used by city fleets and the general public.



Source: California Energy Commission data provided to Tiax, March 2003

Figure 7. Commission $ Spent per Estimated Station Throughput, by Fuel Type

- Among natural gas stations, the CNG and LNG/LCNG stations involving HDV fleets (see Figure 6 bars for Riverside Transit Agency, LA County Sanitation, Omnitrans, and City of Los Angeles) generally require the least amount of Energy Commission funding to displace 1 MMBtu of petroleum fuel. This is generally to be expected for high-fuel-use HDV fleets. However, some HDV fleets that could be expected to be heavy fuel users do not necessarily follow the same trend. In the case of Taormina Industries, the station throughput estimated by the grant recipient was unusually low for a refuse-hauling operation, but no additional information was available.

- It is not too surprising that CNG stations geared for school bus operations would entail relatively low throughput, and thus appear low in cost effectiveness for petroleum displacement. For example, the Calexico Unified School District CNG station rated lowest among all 41 funded stations for cost effectiveness (i.e., it was highest in terms of Energy Commission $ spent per MMBtu of petroleum displacement). This school district currently operates a very small CNG bus fleet, with an annual estimated fuel throughput of just 22,000 GGEs. However, it's possible that Calexico plans to expand the district's CNG school bus fleet in the near future – this is one example of why a relatively costly CNG station may have been justifiable for this application.

- Other trends of the data may initially seem less intuitive, but can be better understood upon examining the specifics of the awarded fueling stations. For example, the cities of Burbank and Fremont each received grant funding for a

CNG station, in the amounts of $125,000 and $144,000, respectively. Burbank's CNG station has been estimated to have a significantly lower cost (in Energy Commission grant dollars) per MMBtu of throughput than Fremont's CNG station. There appear to be two reasons for this. First, the Energy Commission funded only 16 percent of the total cost for the Burbank station, while it funded 28 percent for the Fremont station. Second, the Burbank station, which had a total cost that is about $282,000 higher than the Fremont station, was designed to serve a fleet of roughly 50 light-, medium- and heavy-duty NGVs. By contrast, the Freemont station appears to be geared towards fueling a relatively small fleet of CNG street sweepers. With a three-year throughput estimate for the Burbank station that is more than 10 times higher than the Fremont station's estimate, and given the higher relative cost share by the Energy Commission for Fremont, it is clear why the Burbank station achieves a higher cost effectiveness rating.

Role of Energy Commission Funding to Help Lower Fuel Costs

Under the three AFV infrastructure solicitations, applicants were required to describe a "detailed explanation and quantification on how the Energy Commission's grant award will assist public agencies by reducing their alternative fuel cost over a three-year term." Thus, another objective of this report was analyze and assess the collective input received, as further measure of the program's effectiveness.

One factor to note when considering this issue is that supplying CNG has shifted away from public utilities – today, private entrepreneurs sell most CNG in a similar fashion to how LNG and propane are sold. These private companies set fuel price on actual station costs (equipment and installation costs, raw commodity, taxes, costs of final fuel preparation such as compression for CNG, etc.) plus a mark-up based on whatever the market will bear. The complete equation is largely driven by sheer volume – price breaks are usually given only to large-volume customers under longer-term contracts.

Still, grant funding directly helps by reducing the need for the station owner / operator to amortize capital costs (equipment and installation), which in turn provides immediate savings that may result in a reduced fuel price to end users. Examples of how government grant funding can help reduce the costs of stations and/or the price of fuel at the pump include the following:

- **It can help reduce capital and/or installation costs.** For example, government funding can augment a CNG station's budget enough to allow access to a higher-pressure natural gas line. This increased "suction pressure" allows the station to utilize a gas compressor with fewer compression stages, thereby lowering station capital and maintenance costs. Or, it might allow purchase of a more state-of-the-art compressor system with reduced electricity costs, less oil carryover, longer-lasting piston rings, etc.

- **It can help build stations that offer greater utility to the AFV fleet.** For example, government funding can make the difference between a school bus

fleet purchasing a time-fill CNG station and a fast-fill CNG station. The difference may allow the host school district to use CNG buses on school trips and not just morning and afternoon commuting.

- **It can help build stations with higher throughput capacity.** Turnkey fuel providers are building government-funded CNG stations today with significantly higher minimum capacities than those typically built in the past by gas utilities. Additional gas storage can also be purchased. This allows for station expansion, with the ability to quickly grow an NGV fleet or attract other user fleets. The result can be more vehicles fueled, higher station throughput, reduced costs per gallon dispensed, and a corresponding decrease in fuel cost / price. Without government funding, these stations might be affordable only by HDV fleets with very high fuel throughput (on the order of 20,000 GGE per month).

- **It supports building strategic stations for future demand.** With government funding, private companies are much more willing to build public-access stations, even though such stations may initially lack a critical mass of fueling demand. Initially, such stations may open as low-throughput "spec" stations designed to showcase state-of the-art public access and cardreader systems. However, over the longer run they provide gap closure and increase station density as needed to support government programs and regulations (e.g., SCAQMD's fleet rules). Gradually, fuel prices at such stations are likely to be reduced, as fueling demand is increased. Even stations with known and steady fueling demand (in the form of small anchor fleets) might not be built without government funding. For example, typically a fleet of at least 40 taxicabs is sought by third-party companies to justify building a new CNG station, unless government funding is available to share the risk. Even when minimum fleet size and throughput requirements are met, government funds may mean the difference between building and not building a station.

- **It can help smaller AFV fleets to fuel at a larger fleet's station, and "piggyback" off their pricing structure.** Today's government-funded alternative fueling stations are often required to provide public access (or at least access by other nearby fleets) even when designed for a single anchor fleet. This accommodates nearby smaller AFV fleets in fueling at those stations, and may help them obtain fuel at a lower price than would otherwise be available.

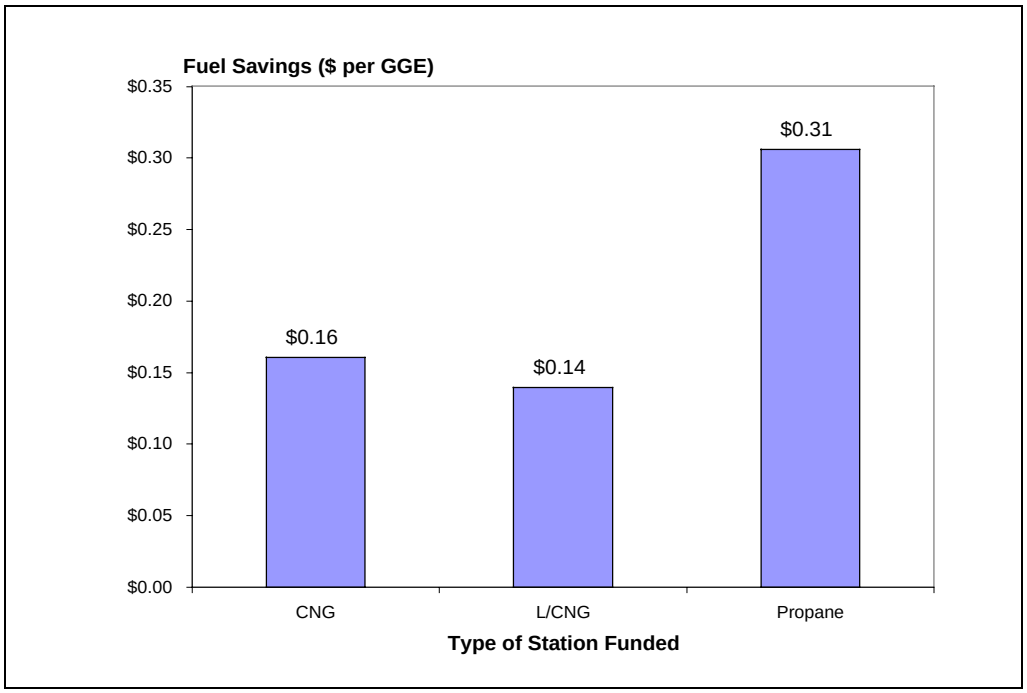
To better understand how the Energy Commission's grant funding helps to reduce station costs and/or prices at the pump for AFV users, input from grant recipients was tallied and analyzed. Inputs were limited and challenging to analyze, as further discussed below along with preliminary findings.

Fuel Cost Savings per GGE

As noted, all grant recipients were asked to quantify how Energy Commission funding for their station can help reduce the cost of alternative fuel *to a* public agency. Perhaps the biggest challenge here relates to the nature of station ownership. Some grant recipients are public agencies that fully purchased their station, so their fuel cost and price will essentially be the same amount. Other grant

recipients are turnkey alternative fuel providers that will own and maintain the supported station for a public agency. In such cases, fuel price to the public agency will be more dependent on volume of fuel used. Another complicating factor relates to selecting the time frame over which the fuel savings will occur. Some stations opened in 2002, while others will not become operational until the second quarter of 2004.

With these caveats in mind, the limited inputs were assimilated, reviewed, and averaged by fuel type to look for trends. Figure 8 shows a breakdown by station type of how grant recipients estimate Energy Commission funding will help save fuel costs for public agencies at the supported stations.



Source: California Energy Commission data provided to Tiax, March 2003

Figure 8. Fuel Savings per GGE by Fuel Type

Given the limitations, data reflected in this figure should be evaluated and interpreted with caution. However, at least one trend appears to make intuitive sense. Figure 8 indicates that the Energy Commission's funding has been (or will be) most effective in reducing fuel costs at the 13 funded propane stations, compared to fuel costs at the CNG or LNG/LCNG stations. As already noted, the throughput estimates for these propane stations may be overly optimistic, which would affect estimates in fuel cost savings. Still, in the case of the new propane fueling stations, a significant market shift seems to be reflected in these data. Currently, small retail stations typically sell propane intermittently for a given consumer, to fuel a gas barbecue or cook in a recreational vehicle. As of mid 2003, the price with tax for propane when dispensed into a 5-gallon cylinder was approximately $3.00 to $3.50 per GGE. To date, the volume of propane dispensed in California for automotive applications has been negligible. However, the state expects to start regularly fueling its 1,610 bi-fuel pickups on propane – this entails

greater volumes and more frequent refueling events. The fully taxed price of propane when dispensed at one of the new automotive stations being built with Energy Commission co-funding is estimated to be $1.70 per GGE (see ***Clean Fuels Market Assessment 2003***). In other words, the 13 automotive propane stations that are being built or expanded in California will support the use of propane in a largely new application. This will potentially result in higher volume sales that will translate to very significant price discounts for end users, which can help deliver annual fuel savings compared to fueling with gasoline.

Overall, grant recipients for natural gas stations also estimated that fuel costs to public agencies will be reduced as the result of the Energy Commission's co-funding. For example, the South Coast Air Quality Management District estimates that more than $50,000 in fuel costs will be saved over three years as a result of the new CNG station that is being built at its facility (see page 29).

Cost Savings with CEC Dollars

In addition to the "principal" funding awarded, the Energy Commission's grant funding has helped public agencies avoid amortizing loans to fund new fueling stations, or upgrades to existing stations. The last column of Table 4 provides the estimated "cost of money" charges that will be realized by each grant recipient over the first three years of the grant award, specifically as a result of the grant funding provided by the Energy Commission.

Table 4.
Estimated Value of Energy Commission Funding Over 3 Years

Grantee	Type of Station	Total Cost of Station(s)	Energy Commission Grant Amount	Estimated Cost Savings* for Grantee Over 3 yrs
City of Los Angeles-East	LNG/LCNG	$3,000,000	$250,000	**$47,754**
City of Los Angeles-West	LNG/LCNG	$3,000,000	$250,000	**$47,754**
Omnitrans San Bernardino	LNG/LCNG	$2,500,000	$250,000	**$216,000**
City of Colton	CNG	$1,700,000	$250,000	**$90,000**
Omnitrans Montclair	LNG/LCNG	$1,700,000	$250,000	**$47,754**
City of Fresno (FAX)	CNG	$1,500,000	$250,000	**$50,000**
San Jose International Airport	CNG	$1,282,333	$250,000	**$31,500**
Yolo Country Transit	CNG	$1,065,968	$100,000	**$82,000**
City of Commerce	LNG/LCNG	$1,000,000	$250,000	**$47,754**
L.A. County Sanitation Districts	LNG/LCNG	$995,070	$250,000	**$26,860**
Delta Liquid Energy 10 sites	LPG (10 sites)	$920,000	$250,000	**$47,754**
Downs Commercial Fueling	LNG/LCNG	$870,000	$250,000	**$47,754**
City of Industry Disposal Co.	CNG	$856,638	$196,427	**$76,311**
Southwest Transportation Agency	CNG	$851,196	$150,000	**$90,000**
City of Visalia	CNG	$850,418	$100,000	**$19,102**
Taormina Industries	LNG/LCNG	$803,862	$241,000	**$46,035**
City of Burbank	CNG	$791,842	$125,000	**$85,689**
City of Placentia	CNG	$750,000	$225,000	**$84,000**
So. Coast AQMD	CNG	$677,975	$169,500	**$42,377**
Yellow Cab of No. Orange County	CNG	$595,000	$100,000	**$19,102**
Calexico Unified School District	CNG	$558,210	$100,000	**$61,731**
SoCal Gas Company	CNG	$550,000	$125,000	**$23,877**
City of Fremont	CNG	$510,299	$144,000	**$21,600**
Santa Cruz Metropolitan Transit	CNG	$384,371	$100,000	**$23,241**
Power Systems Associates	LNG/LCNG	$350,000	$100,000	**$19,102**
UC Santa Cruz	CNG	$282,500	$125,000	**$120,000**
San Luis Butane	LPG	$214,123	$93,063	**$17,777**
Riverside Transit Agency	CNG	$187,434	$30,000	**$14,085**
Pinnacle CNG Company (SJUSD)	CNG	$98,000	$30,000	**$5,730**
Yolo Solano Transit	CNG	$90,000	$30,000	**$5,730**
San Luis Butane	LPG (2 sites)	$63,754	$30,000	**$5,730**
Grand Totals		$28,998,993	$5,063,990	**$1,564,106**

*Values were estimated by grant recipients or a 6% interest factor per year over 3 years

Source: California Energy Commission data provided to Tiax, March 2003

Other Inputs from Grant Recipients

In addition to the types of feedback already described in this report, the South Coast Air Quality Management District provided feedback about some of the more peripheral benefits of the grant funding it received from the Energy Commission. This feedback is summarized in Table 5.

Table 5.
SCAQMD's Input on Importance of Energy Commission CNG Station Grant

Project:	♦ Install new fast-fill CNG station at South Coast AQMD
Total Project Cost:	♦ $677,975
Energy Commission Infrastructure Grant:	♦ $169,500 (25%)
Objective of Project:	♦ Improve station reliability and durability ♦ Upgrade to fast fill ♦ Meeting CNG fueling needs of AQMD's existing CNGV fleet ♦ Enable expansion of AQMD's CNGV fleet ♦ Enable nearby fleets using (or considering) CNGVs to share AQMD's station
Type of Vehicles Fueled at Station:	♦ Light- and medium-duty NGVs for passenger and cargo hauling
Importance of CEC Grant Funding:	♦ Essential – station upgrade would not have been performed without the CEC grant
Other benefits identified by Grantee (AQMD):	♦ Improve basin-wide implementation of CNG vehicles by expanding the CNG station network ♦ Enable AQMD to demonstrate leadership consistent with agency's mission and its role as key participant in the California NGV Partnership ♦ Enable AQMD to demonstrate leadership regarding ways to comply with 1190 Series fleet rules
Impact of Grant Funding on Cost and Price:	♦ Throughput at AQMD's upgraded station is expected to increase significantly ♦ AQMD estimates that it will save approximately $50,274 in fuel costs over three years (assumes CNG at $1.12 per GGE and gasoline at $1.75 per gallon)
Source: Gary Dixon, South Coast AQMD, email to Peter Ward, California Energy Commission, 9/6/2002.	

Conclusions and Recommendations

Role of Program in Context of State and Federal Objectives

The Energy Commission's Alternative Fuel Infrastructure Program is a national leader in supporting deployment of strategic fueling stations needed to effect AFV commercialization. This program is accomplishing the critical mission for which it was designed. Its objectives are consistent with, and complementary to, a variety of other State and federal activities that target reduced petroleum dependency in the transportation sector. For example, at the State level it is helping to achieve the important petroleum-displacement objectives identified under Assembly Bill 2076 and Senate Bill 1170. At the federal level, the program strongly supports California's public and energy-provider fleets in complying with EPACT program requirements. State Energy Program grants alone under the federal Clean Cities program are inadequate to meet the need for fueling station infrastructure. Applications in California under Clean Cities grant funding projects continue to grow in number, and each solicitation has been oversubscribed, especially with regard to applicants seeking infrastructure funding. In sum, the need continues to grow for the Energy Commission's Alternative Fuels Infrastructure Program and other efforts that supplement national efforts.

Summary of Program Results to Date

Many of the fueling stations supported under the Energy Commission's funding only recently became operational, or are still being built. Thus, this evaluation of program effectiveness is preliminary in nature – it can only be based on estimated station throughput and petroleum displacement. Future assessments can utilize actual fueling station data to more accurately evaluate petroleum displacement resulting from the Energy Commission's grant funding.

The allocation of $5.1 million for 41 natural gas and propane stations is a major step forward towards the alternative fuel infrastructure network needed in California to support AFV deployments. While it is too soon to derive any concise estimates about the volumes of petroleum fuels that will be displaced at these stations, early trends based on preliminary input from grant recipients indicate that program objectives are being fully met. By June 2004, when all 41 stations are expected to be operational, grant recipients collectively estimate that nearly 20 million gasoline gallon equivalents (GGEs) will be dispensed annually at these 19 CNG, 9 LNG/LCNG, and 13 propane stations.

Twenty million gallons constitute only about 0.09 percent of California's annual gasoline and diesel consumption in the transportation sector. However, the reduced petroleum usage will largely accrue in California's public fleets, where it is most needed. This includes the state fleet of approximately 73,000 DMV-registered on-

road vehicles, which is subject under SB 1170 to achieving a 10 percent reduction in petroleum usage by January 1, 2005. More than 75 percent of SB 1170 goals for petroleum displacement by 2005 can be achieved through dedicated use of CNG and LPG in the state's fleet of about 3,500 bi-fuel vehicles – occurrences that would not be feasible without the new stations being built under the Energy Commission's program. Moreover, over the longer term, these infrastructure expenditures will play a significant role in meeting the petroleum displacement goals that are now being outlined under AB 2076.

The Energy Commission's funding also plays a positive role in reducing both capital and operational costs at cost-shared stations. The greatest effect appears to be reductions in fuel price at propane stations, largely due to expansion of propane sales into California's lucrative transportation fuels market. Immediately available is the demand for propane to fuel the state's 1,610 bi-fuel pickup trucks, which historically have been driven almost exclusively on gasoline. Propane sales at the 13 new or upgraded automotive stations supported under the Energy Commission's program are expected to translate to very significant price discounts for public fleets using propane vehicles, which can help deliver annual fuel cost savings compared to fueling with gasoline. Fuel costs at CNG and LNG/LCNG stations have also been positively impacted by the Energy Commission's grant funding.

Recommendations

The main recommendations of this evaluation are as follows:

- The Energy Commission's Alternative Fuel Infrastructure Program works well under the existing structure, and should be continued. Prospects appear to be good for the program to achieve its objectives and provide the desired return on investments. While specific funding appropriations for future station allocations are currently uncertain, the program should continue to provide support deployments in others ways, such as preparation of additional studies that can remove station barriers or address problems.

- The Energy Commission should conduct follow-up assessments of actual station throughput and petroleum displacement for all awarded projects in approximately 24 months.

- The Energy Commission should continue to update ***the California Clean Fuels Market Assessment*** and use it to help guide expenditures and targeted support efforts under the alternative fuel infrastructure program.

End Notes and References

[1]The grant for at least one of those 41 stations never came to fruition, although the original funding allocation was announced.

[2] California Energy Commission, California Air Resources Board, and California Department of General Services, "California State Vehicle Fleet Fuel Efficiency Report: Volume I Summary of Findings and Recommendations," Commission Report P600-03-003, May 2003.

[3] Btu is an acronym for British thermal unit, which is a standard unit of heat energy typically used to define the energy content of various transportation fuels.

[4] LCNG is a special feature available for LNG stations. At extra capital cost, hardware is added that produces high-purity CNG by vaporizing and compressing liquefied natural gas at the station. For simplicity, this report refers to all 9 funded LNG stations as LNG/LCNG stations.

[5] Fred Minassian, "importance of Infrastructure to the California NGV Partnership," presentation at the Southern California AFV Expo & Natural Gas Infrastructure Workshop, December 4, 2003.

[6] The state's fleet of nearly 3,600 bi-fuel AFVs may not provide air quality benefits unless operated on CNG or propane, although they can make very significant contributions to petroleum displacement. It is today's dedicated AFVs (especially heavy-duty buses and trucks) that can provide significant air quality benefits while also displacing petroleum fuels.

[7] Note: unlike LNG/LCNG and LPG stations, the awarded CNG stations are likely to vary widely in size, type (fast vs. slow fill, etc.) and intended use. This is important to consider when discussing issues such as average station cost and cost per Btu displaced, as in Section 0.

[8] Santa Clara Valley Transportation Authority, memorandum from Board of Directors meeting, Agenda Item #10, July 2002, online at http://www.vta.org/inside/boards/packets/2002/aug/10.html.

[9] Many of the supported fueling stations will fuel heavy-duty vehicles and therefore displace diesel as well as gasoline. DGE (diesel gallons equivalent) could also be used, but GGE is the better choice when assessing both gasoline and diesel displacement.

[10] Although the City of Colton's grant for a CNG station did not come to fruition, the City's original throughput estimates have been used for this exercise.

[11] The unit of MMBtu is used instead of GGE for this discussion because it directly normalizes to energy content. Alternative fuels dispensed into HDVs (e.g., LNG or CNG for transit buses) will mostly displace diesel, not gasoline. One GGE contains ~90% of the energy in a diesel gallon.